Sample Programs

The ST326 is provided pre-programmed with the ceramic firing programs below. These programs may be modified as required.

Program Number	Program Name	Ramp 1	t1	Ramp 2	t2 Soak Temp	Soak Time	Ramp 3	t3
1	Slow Bisque	60°C/hr	600°C	FULL	1000°C	00:00	End	-
2	Normal Bisque	100°C/hr	600°C	FULL	1000°C	00:00	End	-
3	High Bisque	100°C/hr	600°C	FULL	1140°C	00:00	End	-
4	Brush-on Earthenware Glaze 1000°C (Cone 6)	100°C/hr	300°C	FULL	1000°C	00:00	End	-
5	Standard Earthenware Glaze 1100°C	100°C/hr	300°C	FULL	1100°C	00:00	End	-
6	Earthenware High Temperature Glaze 1140°C	100°C/hr	300°C	FULL	1140°C	00:00	End	-
7	Mid-Range Stoneware Glaze 1200°C	100°C/hr	300°C	FULL	1200°C	00:00	End	-
8	Standard Stoneware Glaze 1260°C (see note)	100°C/hr	300°C	FULL	1235°C	00:00	End	-
9	Onglaze 780°C	100°C/hr	400°C	FULL	780°C	00:00	End	-
10	Lustre 750°C	100°C/hr	400°C	FULL	750°C	00:00	End	-

Note

It has been found that a kiln controller will give greater heat work as the temperature increases. Therefore to achieve a stoneware firing of cone 8-9 we suggest setting the final soak temperature to 1235°C. A slight adjustment can then be made after the first firing. It should be remembered that kiln controllers are indicators of temperature and the effects of faster or slower firings may cause extreme variations in the end result. This is known within ceramics as “heatwork”. Cones are measures of heatwork and it is strongly recommended that cones are always used in conjunction with a kiln controller to appreciate the differences between heatwork and temperature indicated by the controller. Stoneware firings will also demonstrate the greatest potential differences between heatwork and indicated temperature.

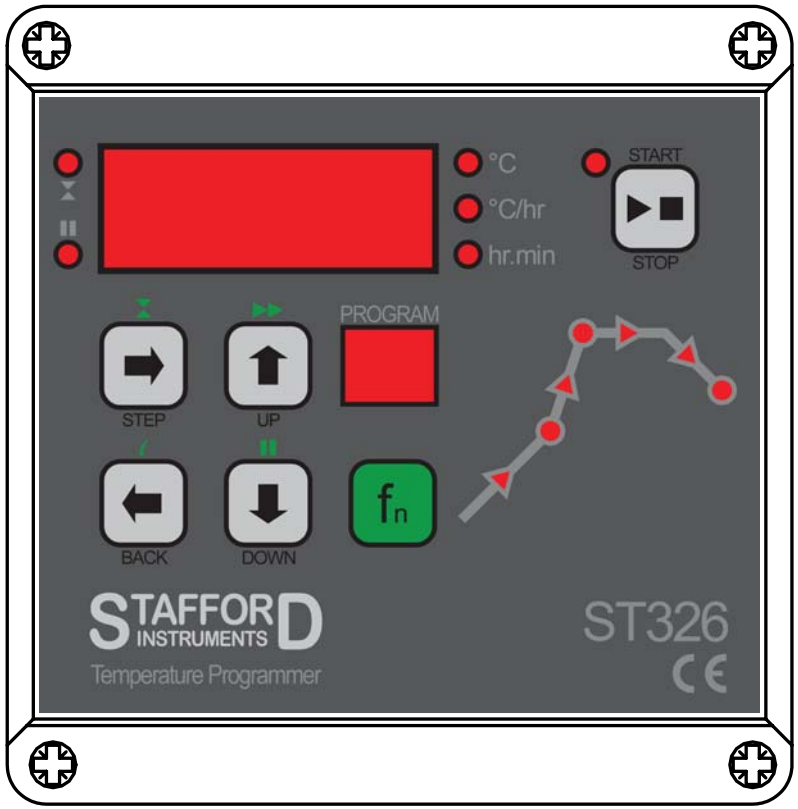
All of the information on this page was kindly provided by Reg Griggs of Clayman Supplies Limited (www.claymansupplies.co.uk).

Further copies of this handbook may be found at www.staffordinstruments.co.uk/docs/st32x/user326.pdf

STAFFORD INSTRUMENTS

ST326

User Handbook



ST326 Temperature Programmer

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See separate handbook for User Instructions

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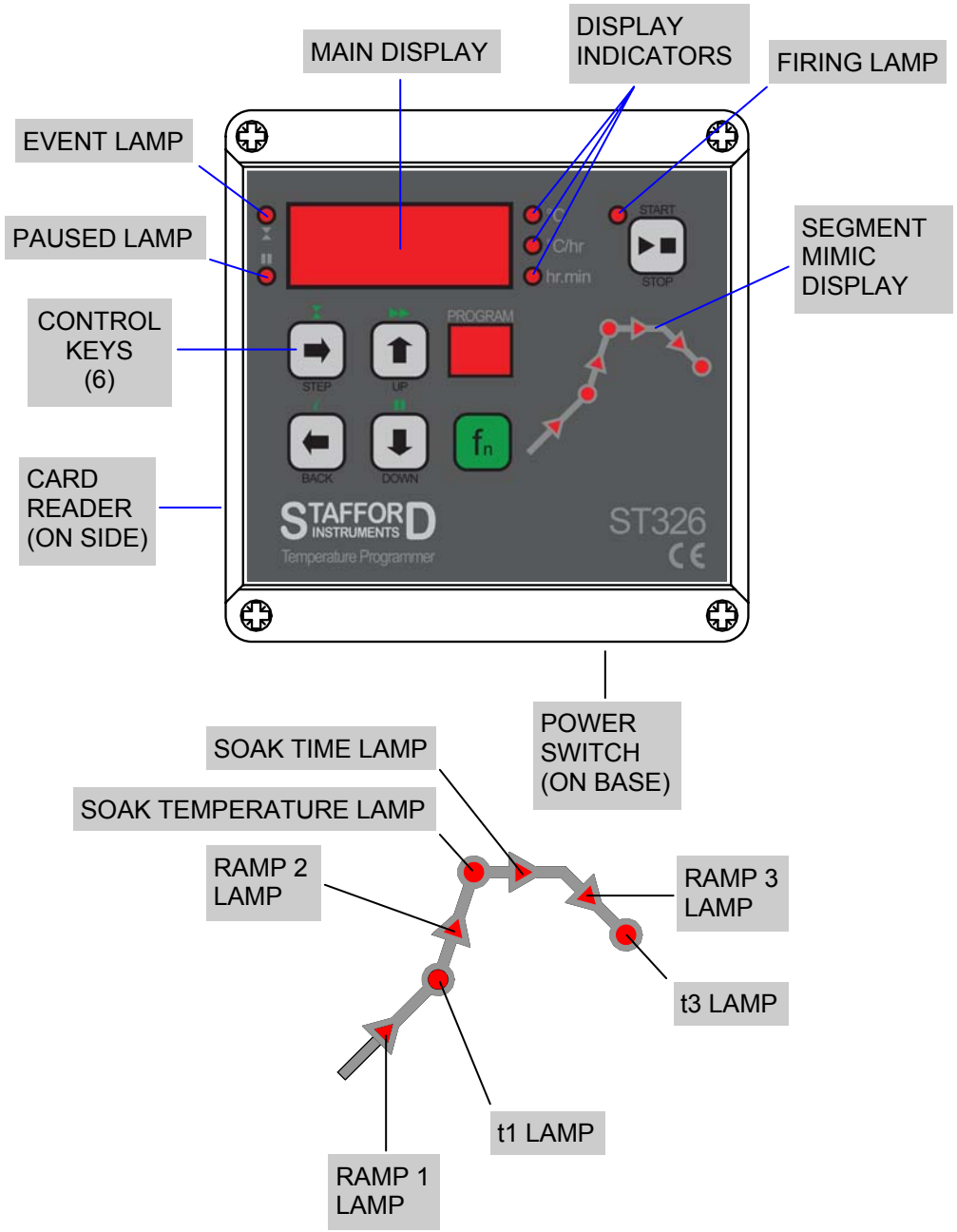
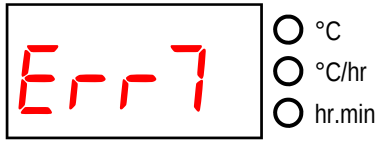
Date: 15 Feb 2011

At A Glance



Error Messages



Error 7. Maximum room temperature exceeded. The internal temperature of the ST325 has exceeded an installer selectable (30 - 70°C) limit.

Possible causes are: room vent fan failure, ventilation grills blocked, kiln room too small, damper or bung left open.

All error messages cause the ST326 to terminate the firing with all the keys locked. **An alarm buzzer sounds once per second.**

SWITCH KILN OFF!

To reset the ST326 turn off the power to the instrument and have the fault investigated and rectified by your installer or kiln service engineer.

Note: these error messages are provided to detect kiln faults and so offer some protection to the kiln. For increased protection the use of a heat fuse or other independent over-temperature trip is recommended - such as the Stafford Instruments ST121.

Technical note: any error message will cause the alarm relay to open - see installation handbook for details.

Error Messages

Err 1

°C
°C/hr
hr.min

Error 1. The kiln temperature is not increasing as required. The kiln has been on full power for 1 hour but the kiln temperature has not risen by at least 8°C.

Possible causes are: kiln door or lid not closed properly, heater element failure, elements too old, power phase failure, contactor failure or thermocouple short-circuit.

Err2

°C
°C/hr
hr.min

Error 2. Thermocouple or thermocouple wiring open circuit. Get thermocouple and wiring checked. Have thermocouple replaced if necessary.

Err3

°C
°C/hr
hr.min

Error 3. Thermocouple reversed (kiln temperature apparently less than -40°C). This is an installation fault. Get wiring checked.

Err4

°C
°C/hr
hr.min

Error 4. Kiln temperature too high. The kiln has been on zero power for 30 minutes but the kiln temperature has not fallen by at least 1°C

Possible causes are: contactor failure or thermocouple connection intermittent or high resistance.

Err5

°C
°C/hr
hr.min

Error 5. Kiln temperature overshoot. The kiln temperature exceeds the desired temperature by at least 10°C - 50°C (installer selectable).

Err6

°C
°C/hr
hr.min

Error 6. Maximum firing time exceeded. The length of the current firing has exceeded an installer selectable (10 - 999 hours) limit.

Quick Start Guide

Switch on & wait for kiln temperature display
To run a firing program set up previously press the START/STOP key
To stop the firing at any time press the START/STOP key again
To review firing data press the ➡ key to enter the programming menu
To change firing data press the ⬆ & ⬇ keys to change the displayed value
Use the ➡ key again as necessary to index to the next firing value or segment to be reviewed or changed
To mark the end of a program set a ramp rate to End with the ⬇ key
To exit the programming menu either wait 10 seconds or press the START/STOP key to start firing
If the keyboard is locked then press the ⬆ & ⬇ keys together & hold down for 5 seconds to unlock

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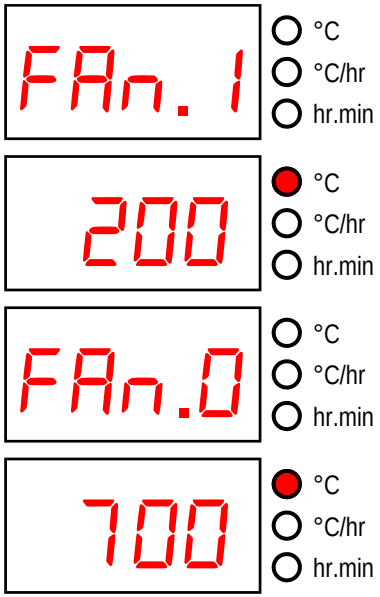
Features

- Multi-zone
- 99 programs
- Program linking option
- Soak times up to nearly 100 hours
- Ramp rates from 1 to 999°C/hour + full
- Ideal for ceramics use
- Programs can be altered while firing
- Program pause + advance facilities
- Event / Damper Relay Output
- Keyboard lockable
- Delayed start facility - up to nearly 100 hours
- Power failure recovery
- Info key for energy used and set point display
- Alarm Buzzer & Alarm Relay Output
- Mains power switch
- Micro-SD memory card reader

Fan Output

To enter damper temperature configuration mode press and hold down the ⬅ & ➡ keys at the same time while the controller is not running a program (FIRING LAMP not lit).

Note: in the sequence below if no key presses are detected within 15 seconds the instrument will exit configuration mode and configuration changes will not be saved.



The fan start temperature prompt is shown. Release the ⬅ & ➡keys. **Press the ➡ key.**

The fan start temperature is now shown. Adjust with the ⬆ & ⬇ keys (hold down for acceleration). **Press the ➡ key.**

The fan stop temperature prompt is now shown. **Press the ➡ key.**

The fan stop temperature is now shown. Adjust with the ⬆ & ⬇ keys (hold down for acceleration) **Press the ➡ key.**

The instrument will now reset and the new fan control temperatures will be stored.

Note: in the sequence above it is important that the ➡ key is pressed a total of 4 times else configuration changes will not be saved.

Fan Operation

At the start of the firing the fan remains off while the kiln temperature is below the fan start temperature. The fan starts when the kiln temperature has risen to the fan start temperature and remains on until the kiln temperature has risen to the fan stop temperature. The fan then turns off and stays off until the end of the program.

Damper Output

To enter damper temperature configuration mode press and hold down the ⬅ & ➡ keys at the same time while the controller is not running a program (FIRING LAMP not lit).

Note: in the sequence below if no key presses are detected within 15 seconds the instrument will exit configuration mode and configuration changes will not be saved.

dPr.C	○ °C ○ °C/hr ○ hr.min	The damper close temperature prompt is shown. Release the ⬅ & ➡keys. **Press the ➡ key.**
150	● °C ○ °C/hr ○ hr.min	The damper close temperature is now shown. Adjust with the ⬆ & ⬇ keys (hold down for acceleration). **Press the ➡ key.**
dPr.O	○ °C ○ °C/hr ○ hr.min	The damper open temperature prompt is now shown. **Press the ➡ key.**
500	● °C ○ °C/hr ○ hr.min	The damper open temperature is now shown. Adjust with the ⬆& ⬇ keys (hold down for acceleration) **Press the ➡ key.**

The instrument will now reset and the new damper control temperatures will be stored.

Note: in the sequence above it is important that the ➡ key is pressed a total of 4 times else configuration changes will not be saved.

Damper Operation

Prior to firing the damper will be open. During firing, when the kiln reaches the damper close temperature, the damper will closed.

At the end of the firing and when the kiln has cooled naturally to the damper open temperature, the damper will open.

Turning On

Turn on the mains supply to the controller using the switch on the base.

8888	● °C ● °C/hr ● hr.min	When turned on the ST326 performs a display test by briefly illuminating all of the display digits and all of the front panel lamps.
F 1.01	○ °C ○ °C/hr ○ hr.min	The version number of the embedded software is now displayed. If you need technical support you may be asked for this code together with the ST326's serial number.

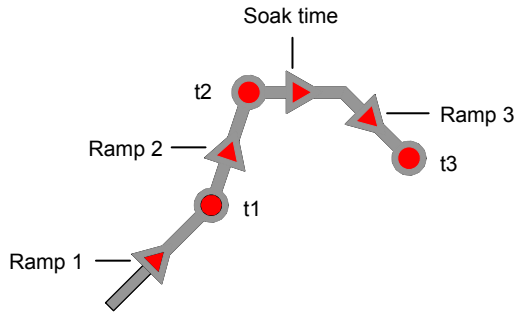
Next displayed is the thermocouple type to which the ST326 is set. This thermocouple type setting should match the type of thermocouple fitted to the kiln and can be R, S, K or N type.

tC.r	'R' type thermo-couple	tC.S	'S' type thermo-couple
tC.H	'K' type thermo-couple	tC.n	'N' type thermo-couple

20	● °C ○ °C/hr ○ hr.min	The final display should show the kiln temperature (20°C shown here) with the '°C' indicator on. All other lamps should be off.
. 20	● °C ○ °C/hr ○ hr.min	If the left-hand decimal point is on then the keyboard is locked. This is an anti-tamper feature. Press the ⬆ & ⬇ keys together & hold down for 5 seconds to unlock.
20.	● °C ○ °C/hr ○ hr.min	If any mimic panel lamps are on then the ST326 is firing. Press the START/STOP key to stop the firing. During firing the right-hand decimal point will light to show when the kiln is heating.

Programming

A Program



An ST326 program comprises of a ramp to an intermediate temperature t1 followed by another ramp to the soak temperature (t2). The ST326 then soaks (dwells) at the soak temperature for the soak time. An optional final ramp to t3 is also provided.

On the mimic panel ramps 1 & 2 are depicted as heating ramps and ramp 3 is depicted as a cooling ramp but actually the ST326 is capable of both positive (heating) ramps and negative (cooling) ramps - and any of the ramps can be set to be either heating or cooling.

Each ramp rate is settable in the range 1°C/hour to 999°C/hour or FULL (full power/full cool) or End (end of program).

The soak temperature is settable over the range 0 to 1320°C.

The soak time is settable over the range 00.00 (no soak) to 99 hours 59 mins.

Ramp 3 can be disabled if not required setting the ramp rate to End (or by setting the ramp rate to FULL and setting t3 to anything less than t2).

A program linking feature is available for complex firings. This feature is disabled by default but can be enabled by reference to the Installation Handbook.

Note: during soaking the ST326 display alternates every 15 seconds between kiln temperature and soak time remaining.

Card Reader

This controller has a card slot for a micro SD memory card (the same type of card as used on many mobile phones). The card can only be inserted one way around with the gold contacts facing away from you (towards the back of the controller).

Files on the card can be used to modify the configuration of the controller.

Card files can also be used to update the operating firmware (software) of the controller if necessary for bug fixes or to add extra features or options.

You could request a pre-programmed card be sent through the post. Alternatively the files may be sent via email or downloaded from our website and then copied on to a suitable card. The controller has been tested with several makes of 1G & 2G micro-SD cards. Suitable cards are available from Stafford Instruments.

Note: to copy files to the card your computer will need either an SD memory card slot or a USB card programmer. You may also need an SD to micro-SD card adapter (often sold with the micro-SD card). Your computer will recognise the card as a removable disk. The files should reside in the root directory of the card/disk. Only FAT16 is supported.

To update the controller first turn it off. Insert the card into the controller's slot. Press and hold down the green fn key while turning the controller on. The °C, °C/hr & hr.min lamps will now flash showing an update is in progress. Release the fn key. Wait for the update to finish (might take up to 2 minutes) then remove the card.

Control Relay

Control Relay Configuration

The ST326 has a relay output that can be configured (see installation instructions) as not used, a damper control output, a fan control output or an event output.

Event Output

While displaying a ramp rate the event relay can be switched on or off by holding in the fn (function) key then pressing the ⧗ (event) key. The event relay will be closed when the event lamp is on.

While displaying a soak time the event relay can be switched on or off by holding in the fn (function) key then pressing the ⧗ (event) key. The event relay will be closed when the event lamp is on.

Other Features

Info Key

Hold down the green fn key and then press the i key to display the energy used in kW hours. If pressed during a firing it shows the energy used so far. After a firing it shows the total energy used for that firing. This information is stored while power is off and is only reset to zero when a new firing is started. If the value displayed is always 0.0 then the kiln power rating has not been configured into the ST326 - see installation handbook.

Keeping the green fn key pressed down, and then press the i key again to display the current set point (target temperature).

Keyboard Lock Facility

The keys on the ST326 can be locked so that pressing them has no effect. This is an anti-tamper feature used to ensure that the operation of the ST326 or the program data cannot be altered by un-authorised people. The ST326 can be locked when it is idle (not firing) or while it is firing. It cannot be locked while it is being programmed.

If the left-hand decimal point in the display is lit then the ST326 is locked. Press and hold in both the ⬆ & ⬇ keys for 5 seconds to unlock the ST326.

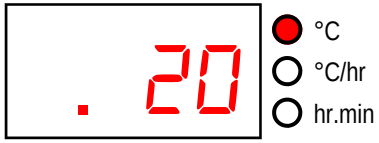
If the left-hand decimal point in the display is not lit then the ST326 is not locked. Press and hold in both the ⬆ & ⬇ keys for 5 seconds to lock the ST326.

Power Failure Recovery

If power fails during firing then the ST326 recovers as follows:-
For power failure during start delay then by default the ST326 times off the remaining start delay when power returns (configurable - can be set to fire immediately when power returns - see installation handbook).
For power failure during ramping the ST326 continues the ramp it was previously executing.
For power failure during soaking the ST326 ramps back up to soak temperature at the correct ramp rate then applies the remaining soak period.
Power failure recovery can be disabled if required (see installation handbook) - the ST326 will then lock up with FAIL displayed and kiln off in the event of power failure.

Changing / entering a program

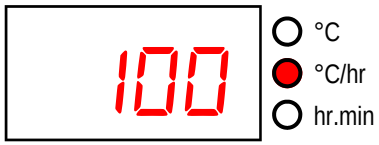
When not firing no lamps lit on the mimic panel, the firing lamp is off and the display shows the kiln temperature with the °C indicator lit. The currently selected program number is shown.



If the left-hand decimal point is on then the keyboard is locked. Press the ⬆ & ⬇ keys together & hold down for 5 seconds to unlock.

Press the ➡ key to select a (flashing) program number. This can be changed as required with the ⬆ & ⬇ keys. There are 99 programs available.

Note: holding down the ⬆ or ⬇ keys causes rapid change of the displayed value.



➡ then displays ramp 1 rate in the range 1 to 999°C/hr or FULL or End. This can be altered with the ⬆ & ⬇ keys. The RAMP 1 lamp on the mimic display will flash.

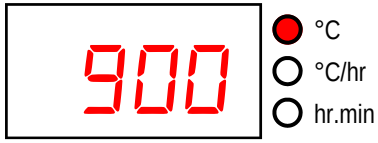
➡ then displays temperature t1 in the range 0 to 1320°C. This can be altered with the ⬆ & ⬇ keys. The T1 lamp on the mimic display will flash.

➡ then displays ramp 2 rate in the range 1 to 999°C/hr or FULL or End. This can be altered with the ⬆ & ⬇ keys. The RAMP 2 lamp on the mimic display will flash.

➡ then displays temperature t2 (soak temp) in the range 0 to 1320°C. This can be altered with the ⬆ & ⬇ keys. The T2 lamp on the mimic display will flash.

The next push of the ➡ key displays the soak time in the range 00.00 to 99.59 (99 hours 59 mins). This can be altered with the ⬆ & ⬇ keys. The SOAK TIME lamp on the mimic display will flash.

➡ then displays ramp 3 rate in the range 1 to 999°C/hr or FULL or End. This can be altered with the ⬆ & ⬇ keys. The RAMP 3 lamp on the mimic display will flash.

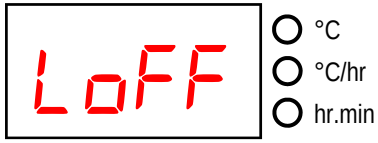


➡ then displays temperature t3 in the range 0 to 1320°C. This can be altered with the ⬆ & ⬇ keys. The T3 lamp on the mimic display will flash.

The next push of the ➡ key exits programming mode if program linking is not enabled. The ST326 is returned to the idle display showing kiln temperature. *Program linking is not enabled by default but can be enabled if required by reference to the Installation Manual.*

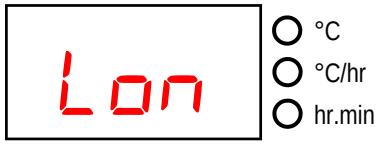
Program linking enables programs to be joined together to form a sequence e.g: 1,2,3 or 42,43 etc. All of the linked programs are run consecutively. Up to 99 programs could be linked together.

If program linking is enabled then the next push of the ➡ key shows the following:-



The display will either show LoFF (link off) or Lon (link on) and can be changed with the ⬆ & ⬇ keys.

If LoFF is shown then this is the end of the linked program sequence. The next push of the ➡ key will exit programming mode and the ST326 will return to the idle display showing kiln temperature.



If Lon is shown then the next push of the ➡ key causes the program number to be increased by 1 and the display prompts for ramp 1 data as shown below.

Displayed: ramp 1 rate in the range 1 to 999°C/hr or FULL or End. This can be altered with the ⬆ & ⬇ keys. The RAMP 1 lamp on the mimic display will flash.

Continue entering program data as required. Terminate the linked program sequence with LOFF.

Program Pause Facility

While firing press and hold down the green fn (function) key then press the ❚❚ (pause) key. The ST326 will pause the executing program. To un-pause the program repeat the above key press sequence. The effects of pausing are as follows:-

If paused during ramping the kiln temperature will be held (soaked) **indefinitely** at the current kiln temperature. The ramp will continue when un-pause is selected.

If paused during soaking then the soak time will be **extended indefinitely**. The remainder of the soak period will be resumed when un-pause is selected.

Segment advance ►► can also be used to terminate the pause. This will advance the segment and will immediately terminate a paused soak - advancing to the next segment (if any).

Changes made to the operation of the ST326 in this way are temporary and are not stored.

As a warning during pause a double beep is sounded every 10 seconds and the display scrolls PAUSEd. The PAUSED lamp to the bottom left of the main display is lit.

WARNING - PROGRAM PAUSE
The program pause facility should be used with care. Program execution is suspended and the kiln will be held at its current temperature indefinitely.

If left too long at high temperatures kiln damage could result.

Adjusting While Firing

Firing values can be adjusted while the ST326 is firing. Also there are program pause/un-pause and segment advance features that are particulary useful for glass work.

Adjusting Firing Values

While firing operate the ➡ key to select the required parameter as shown by a flashing lamp on the mimic display. The firing value is shown on the main display and can now be adjusted with the ⬆ & ⬇ keys in the usual way. The contents of the current segment or any segment still to be executed can be changed. Firing will still carry on as normal while these changes are being made. The ST326 will return to its normal running display 10 seconds after key presses cease (or immediately after End is displayed).

Changes made to programs in this way are stored and are used for subsequent firings.

Program Advance Facility

While firing press and hold down the green fn (function) key then press the ►► (advance) key. The ST326 will sound a short beep and the executing program will immediately advance one step as indicated by lamps on the mimic panel. The effect of this is as follows:-

If a start delay is currently executing then the ST326 will terminate this and start firing immediately.

If ramping to t1 the ST326 will advance to ramp 2, ramping towards t2 at ramp rate 2.

If ramping to t2 then the ST326 will enter soak at the current kiln temperature.

If currently soaking then the soak will be terminated and the ST326 will advance to ramp 3, ramping towards t3 at ramp rate 3.

Changes made to the operation of the ST326 in this way are temporary and are not stored.

Programming Notes

Available ramp rate displays are: End, 1 … 999 & FULL. If full power is required push the ⬆ key until FULL is displayed.

To declare the end of a program while prompted for a ramp rate push the ⬇ key until End is displayed.

To exit programming mode at any time wait 10 seconds without pressing any keys - the ST326 will then revert to the idle display. Alternatively press the START/STOP key to exit programming and to begin firing immediately.

The ⬅ key can be used to reverse through the programming steps to correct errors or to exit programming mode.

Temperature Display

Temperature Dispaly

This section only applies to multi-zone (2 or 3 zones) kilns. A single zone kiln will always show the temperature of zone 1 only.

For multi-zone kilns the temperature of each zone can be displayed. Zone 1 is displayed by default when the ST326 is powered on.

To check which zone / channel is currently displayed press the ⬆ or ⬇ keys. The zone temperature will be displayed again after 5 seconds or if the ➡or ⬅ keys are pressed.

To change the displayed zone / channel press either the ⬆ or ⬇ keys again. Ch 1 & Ch 2 will be shown for 2-zone kilns and Ch 3 will be shown for 3-zone kilns.

To display the zone temperature either wait 5 seconds or press the ➡or ⬅ keys.

Operating Notes

Operating Notes

Kiln too slow

If the ST326 is programmed to heat the kiln at a faster rate than the kiln is capable of then the ST326 will turn on full power then wait until the kiln temperature has risen to the correct temperature before proceeding to the next ramp or soak segment.

Likewise if the ST326 is programmed to cool the kiln at a faster rate than the kiln is capable of then the ST326 will apply zero power then wait until the kiln has cooled to the correct temperature before proceeding to the next ramp or soak segment.

Heating & Cooling Ramps

The ST326 is capable of controlled ramps for both heating and cooling. The type of ramp required is determined by comparing the required soak temperature to the soak temperature in the previous segment and is shown on the mimic display.

STOP key operation

If the START/STOP key is pressed during a firing then the firing will be halted (not paused). Pressing the START/STOP key again will cause the ST326 to restart the firing from the beginning. The ST326 will look at the current kiln temperature and if this is greater than the required soak temperature then the ST326 will automatically *cool* from current temperature to the soak temperature. This may not be what is desired so the STOP key should only be used to halt the firing in an emergency.

The program can be paused or program data can be changed while the controller is firing (see page 14). This is a better option than using the STOP key. The segment advance feature (see page 16) is however available to recover quickly from STOP key operation if required.

Memory

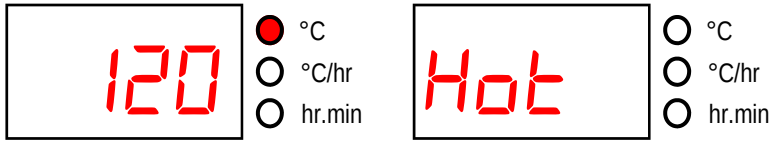
All programs & necessary data are remembered when the ST326 is turned off. In the event of power failure during firing the ST326 will automatically resume firing when power is returned (this feature can be disabled: see installation handbook).

Delayed Start

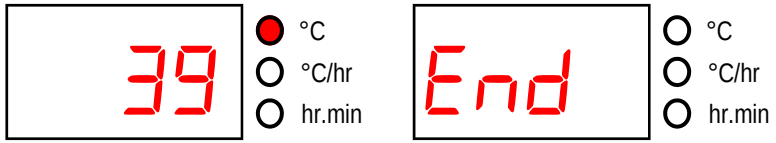
The delayed start time period is by default set to 00.00 when the ST326 is turned on. This zeroing feature can be changed to allow a previously entered delayed start time to be remembered: see installation handbook.

Cooling

Upon completion of firing the ST326 lights all lamps on the mimic display and the kiln is allowed to cool naturally.



While the kiln temperature is above 40°C the display alternates every 5 seconds between the kiln temperature and Hot



When the kiln has cooled to less than 40°C the display alternates every 5 seconds between the kiln temperature and End

To return the ST326 back to idle condition ready for the next firing press the START/STOP key (or turn off the power to the instrument).

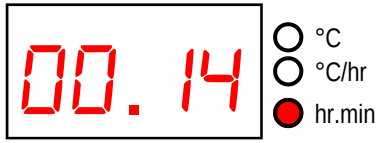
Firing

Hint: it is good practice to check that the program is correct by pressing the ➡ key & checking the program number & program contents before starting a firing.

To start a firing press the START/STOP key. The start delay time will be displayed. The FIRING LAMP will flash - prompting you to change the start delay (using the ⬆ & ⬇ keys). If the delay is 00.00 the firing will start in 5 seconds (or immediately if the STOP/START key is pressed again).

During firing the right-hand decimal point will periodically light - this shows when heating power is being applied to the kiln elements.

When the kiln has ramped to the programmed soak temperature soaking commences for the programmed soak time. The display alternates between showing kiln temperature...



… and showing the soak time remaining.

Information: The ST326 operates by calculating the amount of energy required by the kiln every 30 seconds. If for example 40% of full energy is required to maintain a particular ramp rate or a particular soak temperature then the ST326 will apply heating power to the kiln for 12 seconds every 30 seconds. The right-hand decimal point in the display will light for 12 seconds every 30 seconds. If the kiln has a contactor then a loud click will be heard both when the decimal point lights up and when it goes out. If full heating power is required then the decimal point will remain lit. If full cooling is required then the decimal point will remain off.

Program Record Sheet

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Program No.	Ramp 1 °C/hr	t1 °C	Ramp 2 °C/hr	t2 °C	Soak Time hr.min	Ramp 3 °C/hr	t3 °C	Notes

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